

Eichhornia and Ceratophyllum Monitoring System Based on IoT for Iraqi's Irrigation projects

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ABSTRACT

Advancements in technologies can help solve many problems. Internet of Things (IoT), a recent technology, can be employed to tackle the problems with irrigation systems in Iraq that suffer from agricultural pests. Such pests are known as emergence of bushes and weeds, such as (Eichhornia and Ceratophyllum), that spread in waterways, stream and river back, estuaries, irrigation channels, gates, and systems. They basically impede the flow of water and affect the function of pumps, gates and sprinklers, and can even cause them to stop working. Agricultural pests, in addition, consume huge amounts of water that Iraq critically needs, especially in the years of drought and lack of rain. The present study shows the design of a system, for monitoring and controlling the agricultural pests, that uses IoT Wi-Fi Photon board with a GUI (Graphical User Interface) which is supported with an early notification system. The reasons for the growth of these pests and their spread are discussed in this study. Moreover, there are two methods suggested to limit the emergence of the Ceratophyllum plant and detect of the Eichhornia from an early stage. The results showed that the proposed system is feasible.

Keywords:

IOT, Irrigation Projects, Pests, Eichhornia, Ceratophyllum, GUI.

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1. INTRODUCTION

Iraq has built many irrigation projects on the rivers and tributaries that flow through it. These projects irrigate large areas of agricultural land used to produce crops such as wheat, barley, rice, dates, citrus and many other vegetables and fruits. These products constitute an important and large part of the country's economy, especially after the low oil prices and the emergence of the urgent need to find alternatives to support the economy of the country. The majority of these irrigation projects suffer from aquatic weeds especially Eichhornia and Ceratophyllum.

In [1] and [2], Eichhornia, Water hyacinth, Eichhornia crassipes or locally known as Zahret Al-Nile (Nile flower) in Iraq, violet a large floating violet or purple flower that create an attractive landscape. It's original habitat in the tropics of South America.

Eichhornia consumes large quantities of water daily for its fast growth. According to [3] each plant consumes about 1.3-2.7L/day. It can also present a threat to aquatic life and irrigation systems. It impedes navigation in the rivers and can potentially displace the indigenous water plants leaving a negative impact on the environment. It is very fast growing and reproductive plant.

Iraq has established The Department of Nile Flower and Waterweed Treatment. The Department is affiliated to the Ministry of Water Resources and is responsible to control and solve the problem of these pests. According to this department, the budget for removing this plant is five billion Iraqi dinars per year.

Some official managers in the Department of Water and the Iraqi Minister of Water Resources describe the Nile flower as a green terrorist disease

that invades IRAQ. They encourage the elimination of Eichhornia and stress the importance of saving the marshes and rivers from it.

The plant ranks first among the most dangerous bushes in the world. If the plant spreads or settles in a region, the area is considered to have a water disaster as the plant can cause significant economic losses and water reservoirs causing great losses in quantities of water through transpiration: evaporation of water from the surfaces of the plant's leaves accounts for a loss of 1.5 liters of water per day per flower. It also impedes the flow of water in irrigation channels. It may lead to the emergence of a dense cover or even cause a blockage and disruption of water pumps. Moreover, it forms a shelter for insects that transmit pathogens that affect humans and animals.

Ceratophyllum is the other aquatic pest that focused on in the present study. According to [4] and [5] Ceratophyllum is a submerged perennial plant without roots, which often grows up in the base of the stem buried in sediments, attached to the rivers, lake, and irrigation channels bottom by modified leaves. Hornwort can obstruct the phytoplankton growth in shallow water, which contributes to the stabilization of the macrophyte-dominated state characterized by clear water.

According to a case study in Babel Governorate [6], the budget devoted to the removal, locally known as (sombolan or shombolan), in various mechanical and human methods, from urinals, streams and irrigation canals is 1.25 million Iraqi Dinars/km. This plant reduces the area of the flowing section in canals, drains and streams, and also leads to an unfair distribution of water in these irrigated sections. This is in addition to the increase in water losses due to transpiration processes - evaporation of the plant. It constitutes a good environment for the appearance of abundance of harmful insects that can affect human and animal health. Notwithstanding, the implementation of mechanical methods used to remove these pests is both difficult and not cost effective. These methods consume lots of fuel which, in turn, lead to large amounts of toxic emissions alarming environmental concerns specifically in Iraq which is a developing country. According to [7] the developing countries are at the forefront of the countries that are heavily polluted.

According to what has been mentioned, we learn that these agricultural/aquatic pests constitute a real threat to agriculture, irrigation projects, and even human beings and

environment. According to [8] mentioned that the IoT and sensors network make everything especially agriculture and pests control smarter and easier than before. The Internet of Things can solve many of these problems, perhaps before they occur in the first place or from an early stage.

In paper [9] the IoT is the key to precision agriculture. It turns things from being manual and static to automatic and dynamic.

In addition to this introduction, this paper contains four other sections. Section 2 presents the problem statement. The proposed methodology is fully explained in section 3. The obtained results and their corresponding discussions and conclusion are included in section 4. Finally, section 5 is the future work.

2. PROBLEM STATEMENT

Through many field trips done by the authors, we have noticed the presence of these two pests largely in Iraqi irrigation projects, as seen in figs. (1a, 1b) which represent the Ceratophyllum in one of irrigation channels and the use of a dredger to remove it. Figs. (2a, 2b) show the infection with the Eichhornia in some projects in Mosul. The specialists working at the site unanimously emphasized that these two banners exhaust efforts to maintain unobstructed flow of water in the channels and that their removal demands huge funds. IoT smart design contributes to the elimination or early detection of the plant or early detection to treat them early.



Fig.1a: Ceratophyllum on one of irrigation channel

Fig.1b: Ceratophyllum removal Using a mechanical dredger



Fig.2 a,b :Infection with the Eichhornia in the some projects in Mosul

3. PROPOSED DESIGN METHODOLOGY

We noted from [10] and the literature mentioned in references [4 and 5] that the Ceratophyllum plant is very difficult to eliminate because of many obstacles inherent in the process of removing it by mechanical and manual methods beside the high removal cost. This plant has seeds that have the ability to spread and remain in a state of lethargy for up to 15 years. It has the ability to regrow again if appropriate conditions are available. Therefore, the present study resonates with the importance of "prevention is better than cure". Based on the previous researchers and sources, the most important reason for the emergence of this plant, especially in the irrigation canals, drains and irrigation streams, is the little amount or shallow water depth that leads to light reaching the bottom of these facilities, and thus the Ceratophyllum grows.

As indicated in [6], the second important reason for this plant to appear and grow is the stagnation of water and its non-flowing, which leads to less water turbidity and increased water transparency; consequently, the sun reaches sediments at the bottom of the irrigation facilities and the plant grows. References [11] & [12] were able to maintain a certain level of water inside a tank using the ultrasonic sensor and an Arduino microcontroller board.

Therefore, we used the ultrasonic sensor installed at the top of the irrigation channels, streams and spacers as shown in fig.3.

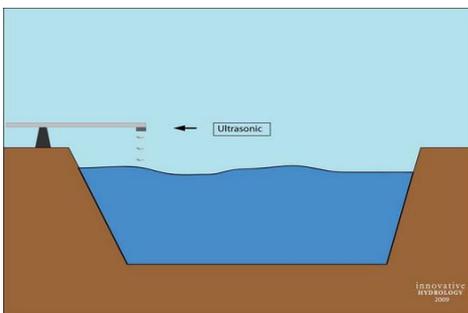


Fig.3: Ultrasonic sensor installed above

This is linked with other sensors of the National Smart Irrigation Project (soil moisture, temperature, smoke and motion sensors) that we are working on as shown in fig.4. and through the Particle Cloud to the Blynk program on the mobile of the person responsible for closing and opening the irrigation gate to maintain a certain water level that prevents this plant from appearing.

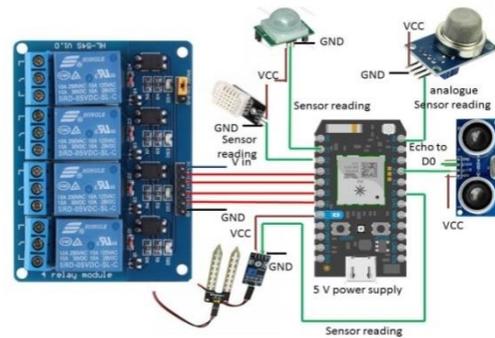


Fig. 4: circuit diagram for smart irrigation system

As the name implies, ultrasonic sensors measure the distance using ultrasound; one of the sensor heads emits ultrasound (T) while the second head receives the reflected wave (R) from the target as shown in figure (5).

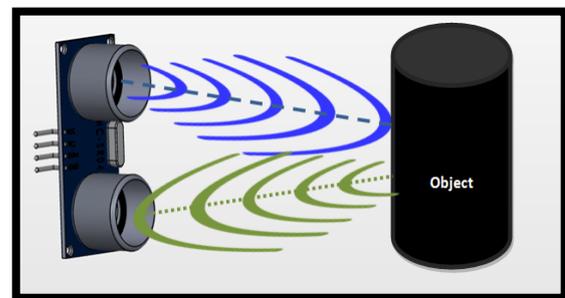


Fig.5: Ultrasonic sensor operation method

Ultrasonic sensors measure the distance to a target by measuring the time between the transmitter and the receiver. To connect this sensor, we need a 5V power which is necessary for the sensor to work properly. When connecting the sensor to a 3.3V voltage source, it would give incorrect results.

The Trig pin must be connected to an analog port on the development board, while the Echo pin must be connected to a digital port for the same board to obtain accurate results. It measures dimensions ranging from 1-160 inch. On the other hand, because of the vast extent of lands, the water irrigation projects, the engineers informed us, feed many channels, some of which yield no benefit. However, the ultrasonic sensor installed on these channels indicates the same reading for a long time without change. This is something that should draw the attention of officials for the purpose of heading to that channel and blocking water to maintain a level of water in the rest of the other channels that irrigate the lands and to reduce the process of evaporation of water which reduces the likelihood of the emergence of a Ceratophyllum plant.

On the other hand, we note that, according to the mentioned research above [1, 2, 3] and [13], Eichhornia dramatically spreads and nothing can prevent or limit its growth when appropriate conditions such as the relatively high temperature and water are available.

Eichhornia has a beautiful appearance and lack of knowledge about its potential threats to water and irrigation projects have concealed the fact that it is a harmful pest. Moreover, people purchase it as an ornamental plant in parts of Iraq.

After initializing and contacting the router to obtain the internet, the program sends a request to obtain the necessary weather information for the work of the National Smart Irrigation Project. After that the system begins by reading the values of all sensors attached to the development board and displaying them on the graphical interface and Blynk application, with respect to ultrasonic sensors. If the reading is greater than the threshold limit (this means that the water level in the channel is low) a warning message is sent to the person's email to reset the irrigation gate. Fig.6 shows the block diagram of the proposed system.

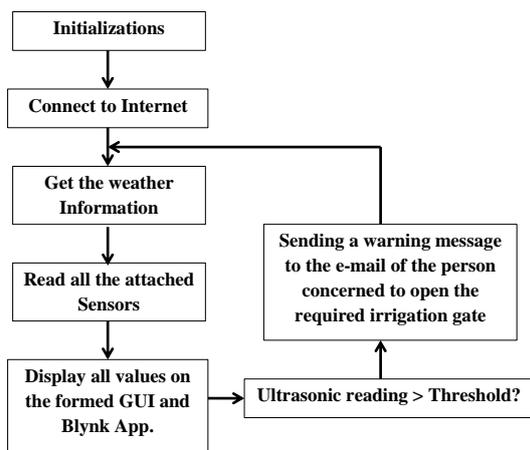


Fig.6: Block diagram of the proposed system

We noticed that the danger of this plant lies with the amazing speed of its reproduction, as mentioned by [14]. One plant of the Eichhornia multiplies to become 100 plants and occupies a swab 20 times the area it occupied at the beginning after four weeks. So this plant should be detected early as shown in Figure 7. It turns out the extent of the weeds in some projects due to the late detection and treatment.

We suggested using drone planes to patrol along rivers in Iraq during the period of growth and reproduction of this plant (during the summer).

According to [8], the UAVs Unmanned Aerial Vehicle (drones) with GPS are used in the agricultural sector to cover vast and large areas of land. UAVs provide “eye in the sky” because of the high resolution cameras that give a great picture. UAVs are being used in a range of agricultural applications, including planting, crop health monitoring, plant counting, agriculture photography, spraying and many other variable rate applications. After being equipped with automation and GPS capabilities, they are ready to take the agriculture sector to a further modernized level.

References [15] & [16] ensure that drones can detect pests, weeds and other diseases that infects the plants because of the great development taking place in the drone technology. They mentioned that everyone who used the drone in agriculture has achieved tremendous benefits. Research [17] used drones with HD pro camera, node cu 8266 and employed ANN for weeds and pest detection. The system is used to carry out image processing and monitor the fields. The results were great in the detection of diseases, weeds and the estimation of the correct quantities of pesticides and the fertilizers needed to obtain crops of good quality and quantity.

Research [18] mentioned wonderful capabilities of the drones with image processing capabilities.



Fig.7: Eichhornia extent, large size of flowers, leaves and stems are clearly obvious.

processing and extracting the necessary information to make specific decisions.

Therefore, we suggested using the drones- especially in the hot months of the year when these plants increase at a huge rate- in monitoring the emergence of these harmful plants and eliminating them before they spread. The features

of drones by reaching remote areas that cannot be easily accessed by humans. Moreover, their high speed and accuracy in covering large areas in a short time make them perfect for early pest detection.

4. RESULTS AND DISCUSSIONS WITH CONCLUSIONS

The use of the Internet of things cannot be neglected in controlling and treatment of weeds and harmful weeds, so with the use of ultrasonic sensors and linked over irrigation canals, to the mobile phone of the person responsible for opening and closing irrigation gates can maintain a certain water level that reduces the appearance of the Ceratophyllum plant.

Fig. (8) shows an image for a GUI that is designed by the authors of the National Smart Irrigation project. It shows the reading of several sensors. However, this study has focused on the reading of the water distance/depth received from the ultrasonic sensor installed on the top of the irrigation canals.



Fig.8: GUI designed by the authors for the national smart irrigation system focusing on the ultrasonic sensor readings

As shown, the reading refers to 85.5inch, and if we know that the depth of the irrigation canal is approximately 120inches, then this means that the height of the water at present is approximately 34.5inch.

Another example is shown in Figure 9, where it shows another reading for a different ultrasonic sensor published on a

blynkapplication. That can be used on a mobile phone making it accessible to anyone anytime anywhere. The results showed that the system is feasible.

The present research finds that there is, surprisingly, a ban on the use of UAVs with built-in cameras to help detect Nile flower plants as it requires obtaining formal and fundamental approvals from the security authorities in Iraq. It is difficult to obtain them, especially in light of the current security conditions and challenges the country is going through, they are prohibited from selling in the local markets, and there is also a ban on their purchase from the World Wide Web.



Fig.9: Ultra Sonic sensor reading in Blynk App on mobile Phone focusing on the ultrasonic reading

Through many researches that dealt with this topic and some of which are mentioned above, we expect to obtain impressive results in the field of early detection of the Eichhornia by using UAVs. The system that is able to determine whether a plant is infected with a specific disease, through a shape or effect on its leaves, will definitely be able to determine the whereabouts of this harmful plant.

5. FUTURE WORKS

There need to be attempts to obtain official and fundamental approvals from the competent security authorities in the country to import or purchase UAVs. Moreover, for practical detection of the Eichhornia plant, early detecting systems

need to be implemented and integrated with an efficient image processing system. This feature can be added to the National Smart Irrigation Project (NSIP) that the authors working on to be a complete system.

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نظام مراقبة زهرة النيل ونبات الشمبلان بالاعتماد على انترنت الاشياء في مشاريع العراق الإروائية

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الملخص

تستخدم التكنولوجيا الحديثة ومن ضمنها انترنت الاشياء في معالجة الكثير من المشاكل في مختلف المجالات ومن ضمنها الري. تعاني مشاريع الري العراقية من العديد من المشاكل لعل من اهمها هي الآفات الزراعية مثل الأعشاب والحشائش الضارة مثل (زهرة النيل ونبات الشمبلان) المنتشرة على ضفاف الأنهار ومشاريع المياه وفي قنوات المشاريع الإروائية و منشآتها الحيوية وتؤثر على عمل بواباتها وانظمتها بشكل عام. هذه النباتات تعيق جريان وتدفق المياه وتسبب عطب المضخات والأجزاء الألية والميكانيكية للبوابات والمرشات وتؤدي الى توزيع غير عادل للمياه والأهم من كل ذلك فهي تستنزف المياه العذبة بكميات كبيرة وهو ما يحتاجه العراق كثيرا خصوصا في سنوات الجفاف وقلة هطول المطار.

في هذا العمل سلطنا الضوء على تلك الآفات , اسباب نموها وتكاثرها وانتشارها , ثم استخدمنا تقنيات انترنت الاشياء عن طريق تصميم وبناء دائرة عملية بالاعتماد على جهاز الواي فاي فوتون مع تصميم واجهة تفاعلية مدعومة بنظام تنبيه لتقديم طرق تحد من انتشار ونمو نبات الشمبلان كما قمنا باقتراح طريقة للكشف المبكر عن زهرة النيل . النتائج اظهرت ان هذا النظام فعال ويمكن استخدامه في مشاريع العراق الروائية.

الكلمات الدالة :

تقنية انترنت الاشياء, مشاريع الري , الآفات الضارة , زهرة النيل , نبات الشمبلان, الواجهة التفاعلية للمستخدم.